Potential impacts of climate change on Pacific Northwest agricultural diseases and pests

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Area in which I have been working for 30 years; mid 1970s, at the National Center for Atmospheric Research in Boulder Co where I became involved in questions of how climate change might impact plant pathogens

…as part of larger conversation on provision of adequate food supply

….indeed my initial engagement was through conversations with Dr. Stephen Schneider

Although my talk focuses on plants, there are pests/pathogens of animals and humans that are similarly being impacted by climate change

Vectors of pathogens are especially relevant to the Pacific Northwest where precipitation is plentiful

Climate impacts Pests and Pathogens

- geographic distribution
  - **very dependent on environment for pest/disease development**
- number of life cycles
  - **often exist at low levels but erupt into epidemics rapidly under favorable conditions**
- ability to overwinter
- control options
- abundance of monoculture ideal

Focus on climate warming with increased precipitation

- **Influence pathogen, pests**
  - Increased overwintering may > severity
    - voles in grass seed fields
    - Dothistroma needle blight on lodgepole pine
    - wheat stripe rust
- **Influence host**
  - Rapid growth, increased canopy humidity
- **Influence vectors of pathogens**
  - **increased overwintering, early movement**

For sake of example, and to increase funding options, entomologists and plant pathologists tend to think in terms of “greater” scenarios

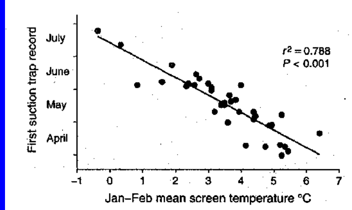
In truth, there will likely be increases in some diseases/pests and decreases in others as a result of climate change

Impact on Perennial crops

Soil borne pathogens

may be particular challenges

Evidence of aphid vectors responding to climate warming



Aphids in Britain

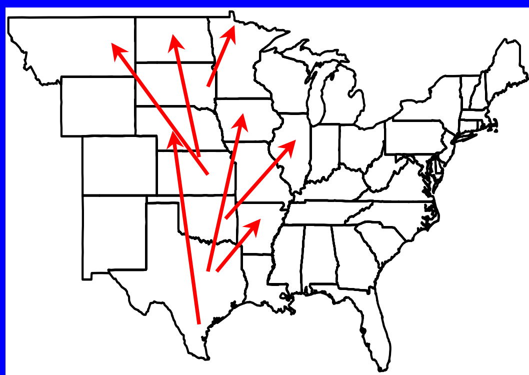
- Suction trap network since 1964
- First spring catch related to winter T
- Advance of spring flight phenology by 3 to 6 days in past 25 years (Fleming & Tatchell 1995)
- During same period, T increased by 0.4^{o}C

Harrington (2002)

Data are for green peach aphid

Aphid vectors important in virus disease transmission

Time of Stem Rust Appearance in the Central United States



- Data collected as part of USDA Cereal Rust Survey since 1920s
- Includes time of first observations of symptoms in different regions
- Compared for two periods post-barberry eradication:
  - 1968-1977 -- cool period
  - 1993-2002 -- warm period

Time of first detection in east-central South Dakota: late June early July

Most severe and least predictable disease and pest outbreaks

- **When geographic ranges are altered by climate change**
- **Allows formerly disjunctive species and populations to converge**
  - **Introduction of pathogen that spreads to new hosts (sudden oak death, Dutch Elm disease)**
  - **Introduction of new plant which encounters pathogens native to area (wheat to Brazil, coffee to Asia)**

Unexpected convergence of a new host with a pathogen may lead to subsequent epidemics

Diseases may exist at levels that do not attract attention until there are economic or aesthetic losses

e.g. Sudden Oak Death present in wild and ignored because the tan oak species it was killing was a "weed" to foresters

An example from Invasive pathogens

- Are both cause and consequence of global change
- In US, cost $137 billion per year; 20% due to exotic plant pathogens (Pimentel *et al*. 2000)
- By 1991, 239 exotic plant pathogen species in US
- Rate of introduction:
  - 1940-70: <5 per decade (NRC, 2002)
  - 1990s: considerably higher

- Happens globally
- Anthropogenic
- Has intensified over past 25 years
- Has major impacts on natural and managed systems

Exotic Plant Pathogens First Detected in the US in the1990s

Field crops

- Sorghum ergot
- Soybean rust (Hawaii)
- Karnal bunt

Forests

- Eurasian leaf rust of poplar
- Leaf spot of hybrid poplar
- Sudden oak death
- Needle blight of spruce

Ornamentals

- Powdery mildew of *Sedum*
- Powdery mildew of *Nandina*
- Powdery mildew of poinsettia

Fruits and vegetables

- Cucurbit aphid-borne yellows virus
- Cucurbit yellow stunting disorder virus
- Powdery mildew of tomato
- *Phytophthora* rot of cabbage
- Plum pox virus
- Tomato yellow leaf curl
- Citrus canker

Some likely introduced earlier

Some pathogens are species specific, e.g. the powdery mildews

Others have wide host ranges

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Powdery Mildew
Photo by Cynthia M. Ocamb, 1998

First introduced to Pacifica Northwest, Washington, in 1997

Powdery mildew on hops

- introduced into Pacific Northwest in 1997
- is a cool temperature powdery mildew and grows between 54 and 83^{o} F
- summers with high temperatures (over 87^{o} F) have less disease
- cooler temperatures with higher humidity increased disease in 2005

Powdery and downy mildew both require living plant material in order to survive

Both can overwinter in crowns of hops

At present, sexual stage is not present for powdery mildew---should it become prevalent, control is likely to be even more difficult

Hop cone tip blight

Photo by Cynthia M. Ocamb, 1998

Favored by free moisture

Cased by two Fusarium fungal species (F. avenaceum and F. sambucinum

Downy Mildew is favored by higher rainfall and cooler temperatures and can survive a wider temperature range than powdery mildew

Spider mites photo by Jack Kelly Clark

Host here is not hops!

Spider mites are a major problem on hops, indeed were the most important problem until powdery mildew arrived

Mites are worse in hot/dry weather

Warmer summers and lower humidity will favor

Q biotype whitefly

http://www.mrec.ifas.ufl.edu/LSO/Whitelfies.htm

New introduction from the Mediterranean region; first found in Arizona in December 2004 when determined to be resistant to normal control tactics

Less susceptible to many of the insecticides currently used for A and B biotypes

Emphasize IPM principles of pest monitoring, prevention, and sanitation

Wheat stripe rust photos by Bob Powelson

Stripe rust in the PNW

- Disease present since early 1900s
- Became economically important in 1960s
- New cultivars bred had temperature sensitive resistance genes
- Demonstrated that trend of increased winter temperatures and cooler springs increased frequency of disease in 70s

Dothistroma Needle Blight photo by **Everett Hansen, 1987**

Dothistroma Needle Blight

- damage historically low in North America where both disease and host are native whereas severe in Southern Hemisphere where both host and disease introduced
- currently causing extensive defoliation and mortality in plantations of lodgepole pine in northwestern British Columbia
- local increase in summer precipitation appears to be responsible

Large plantations of genetically similar trees (now predominant) have increased problem

Conclusions

- Challenge will be rapid identification and management of new diseases and pests
- Tools for management will change under changing global conditions
  - e.g. water quality issues may preclude use of certain chemical controls
  - phase-out of methyl bromide
  - resistance to chemicals with increased use

Conclusions (con't)

- Important lessons can be learned from studying patterns of pathogen/pest invasions and pathogen/pest evolution in response to global change
- Where hosts go, pathogens/pests will follow
- Best management will be from exclusion or early detection and elimination where possible

What is the best strategy to respond with?

- Maintain ability to respond to new pathogens/pests through research and extension
  - Many states are rapidly losing this ability due to retirements and failure to train new scientists
- Partner with regional institutions and agencies to maximize efforts in education, research, and extension
- Support national efforts such as Plant and Animal Diagnostic Networks